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ABSTRACT

This booklet, one of a series of 17 developed at Prince George's Community College, Largo, Maryland, provides an individualized, self-paced undergraduate organic chemistry instruction module designed to augment any course in organic chemistry but particularly those taught using the text "Organic Chemistry" by Morrison and Boyd. The entire series of modules covers the first 13 chapters of the Morrison-Boyd text in great detail. Each module has been provided with from one to three audiotapes, available from Prince George's Community College, to provide students additional explanations of particular concepts. Each module includes a self-evaluation exercise, a reference guide, worksheets to be completed with the audiotapes, answer sheets for the worksheets, a progress evaluation, an answer sheet for the progress evaluation, an answer sheet for the self-evaluation exercise, an introduction to the topic covered by the module, and student performance objectives for the module. The topic of this module is alkenes, Sp2 hybridization, geometric isomerism, and nomenclature. (SL)

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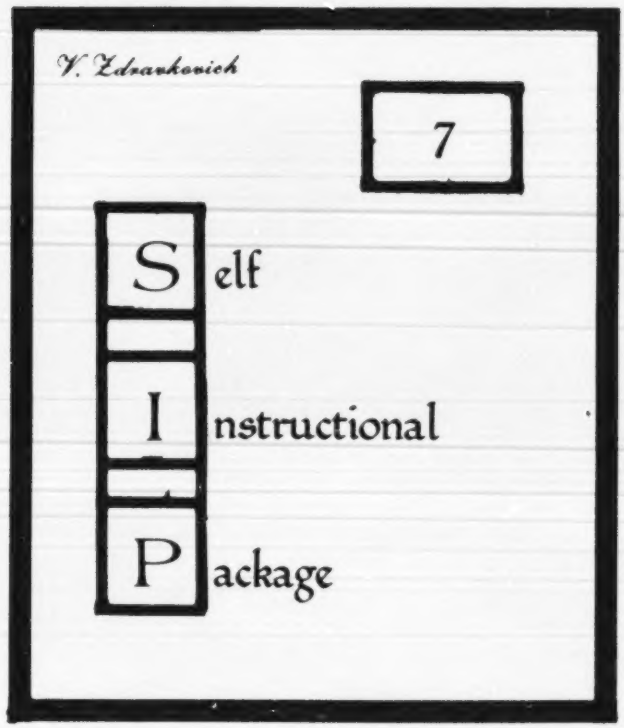
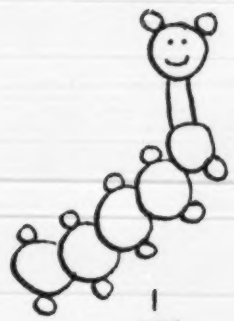
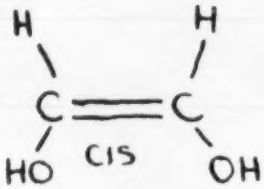
ORGANIC CHEMISTRY

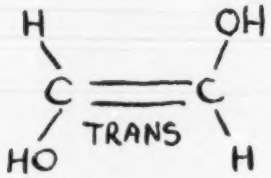
I AM ETHYLENE



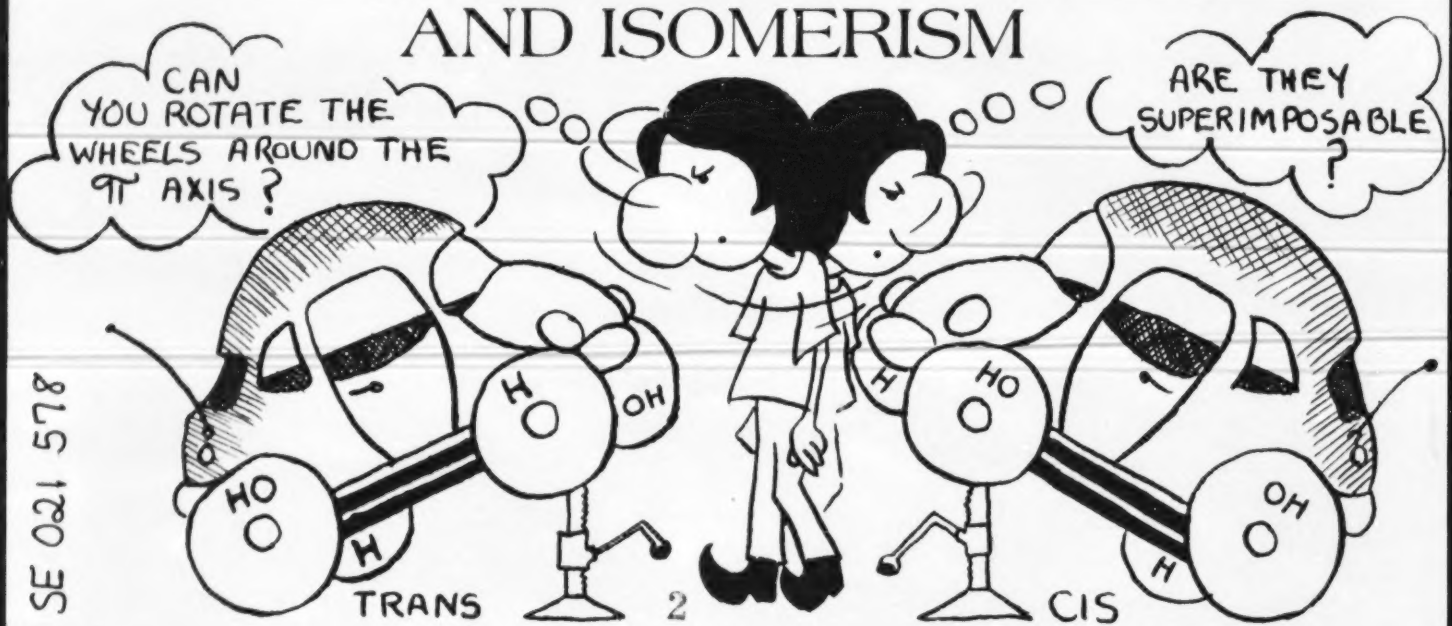


I AM PENTENE





ALKENES-NOMENCLATURE AND ISOMERISM



SE 021 578

Self Instructional Sequence in

ORGANIC CHEMISTRY

"Copr.," V. Zdravkovich 1976

What is it? A learned man could give it a clumsy name. Let him name it who can, the beauty would be the same.
Tennyson---

Self Instructional Package No. 7

ALKENES

Sp^2 Hybridization, Geometric Isomerism, Nomenclature

Walking in the country, lost in thought, you suddenly found yourself in a deep forest. The trees were tall and full of branches. They obscured the sky from your sight and you found yourself completely lost. All of a sudden, on one of the trees, you spotted a sign. It said, "Follow these directions and you will find your way out of my maze." The directions were as follows: Find the tallest tree and turn right. Pass the next few trees until you reach the tree with the longest branch. Then, turn left and proceed in that direction until you find the tree with four branches of the same kind. Turn right and continue in that direction until you find the tree with the same number of branches. Turn right again and you will find yourself in the clearing.

Can you imagine yourself measuring the trees and the branches, counting and comparing each branch? Of course not. But what if in addition to these directions, there was another sign which read: Trees in this organic forest depict the alkenes listed underneath. Without this knowledge you will be lost forever.

Complete the forms and assignments in this Self Instructional Package in order that at the end of it, you may be able to solve the puzzle and walk out of the forest safely. Otherwise, you will be lost in a jungle of ignorance in this particular discipline forever.

Self Instructional Package No. 7
Form A - List of Objectives

ALKENES

Sp^2 Hybridization, Geometric Isomers, Nomenclature

Definitions

The student will be able to define or describe and illustrate with appropriate examples when applicable the following terms: Sp^2 hybridization, π bond, double bond, geometric isomers, cis and trans isomers, Z and E isomers.

Bonding and Sp^2 hybridization

The student will be able to explore and describe the steps in the Sp^2 hybridization.

The student will be able to explain and describe the formation of the π bond and different σ bonds.

The student will be able to describe the shape of ethylene and to identify the magnitude of the bond angles in ethylene.

Geometric isomerism

The student will be able to identify the alkenes which can exist as geometric isomers.

The student will be able to draw the Z and E configurations of different geometric isomers.

The student will be able to assign the correct Z and E specifications to the given configurations.

The student will be able to compare the characteristic properties of geometric isomers to those of conformational isomers, enantiomers and structural isomers.

Nomenclature

The student will be able to assign the correct IUPAC names to different alkenes.

The student will be able to draw the correct structure which corresponds to the given IUPAC name.

The student will be able to draw the correct structure from an incorrect name and assign the correct IUPAC name to it.

Self Instructional Package No. 7
Form B - Self Evaluation Exercise

ALKENES

Sp^2 hybridization, geometric isomerism, nomenclature

Circle the correct answer or answers in each question below.

1. Identify the alkene in the set of compounds given below.

   a) C_7H_{16}

   b) C_3H_6

   c) C_4H_{10}

   d) C_5H_8

2. The following statements about the 2-pentene are correct:

   a) C_1-C_2 bond results from the overlap of Sp^3 A.O. on carbon 1 and Sp^2 A.O. on carbon 2.

   b) C_3-H bond results from the overlap of Sp^3 A.O. on carbon 3 and S A.O. on hydrogen.

   c) C_1-C_2 bond is longer than C_2-C_3 bond.

   d) C_2-C_3 bond is longer than C_4-C_5 bond.

3. Select the correct statements below:

   a) An Sp^2 hybridized carbon has a tetrahedral shape.

   b) An Sp^2 hybridized carbon forms bond angles of 120°.

   c) In the Sp^2 hybridization one S A.O. and two p A.O. "mix" together.

   d) Every double bonded carbon is characterized by Sp^2 hybridization.

4. The statements which are not correct are:

   a) Ethylene is flat because both carbons are Sp^2 hybridized.

   b) The shape of an alkene molecule is determined by the shape of the atomic orbitals on the carbon atoms.

c) All carbon atoms form tetrahedral bonds.

d) 1-butene is a planar, flat molecule.

5. Cis and trans 2-butene have the following characteristic properties:

a) they are not superimposable.

b) they are mirror image isomers.

c) they have the same structure.

d) They have different physical properties.

6. The alkenes which can exist as geometric isomers are:

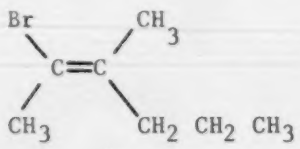
a) 2-methyl-2-pentene

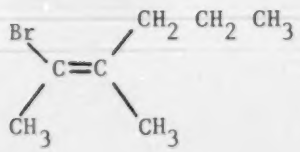
b) 3-heptene

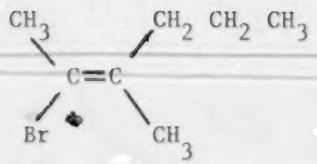
c) 3-bromo-4-methyl-3-heptene

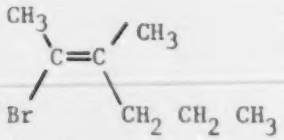
d) 3-ethyl-3-heptene

7. Identify the Z configuration of 2-bromo-3-methyl-2-hexene.

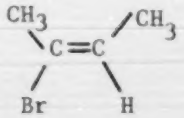
a) 

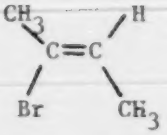
b) 

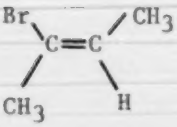
c) 

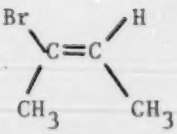
d) 

8. Identify the E configuration of:

a) 

b) 

c) 

d) 

9. Identify the correct statements about the geometric isomers.

a) they are diastereoisomers.

b) they owe their existence to the hindered rotation around carbon-carbon double bond.

c) they can be converted into each other.

d) they are nonsuperimposable mirror image isomers.

10. The correct statements about the π bond are:

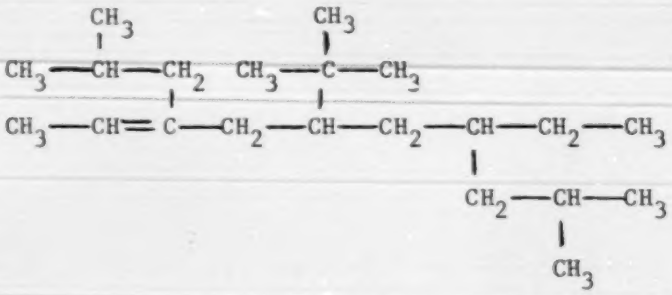
    a) it consists of two lobes perpendicular to the carbon skeleton.

    b) it results from the overlap of the p A.O. on carbon one and the p A.O. on carbon two.

    c) it contains four electrons.

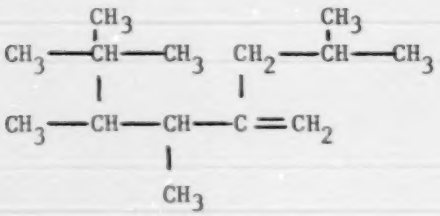
    d) carbon-carbon π bond is weaker than a carbon-carbon σ bond.

11. The longest carbon chain in the alkene below consists of how many carbon atoms?



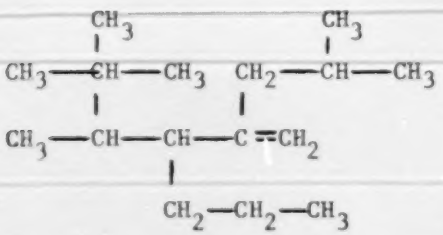
    a) 9
    b) 10
    c) 11
    d) 12

12. The alkene with the structural formula given below can be considered a derivative of which alkene?



    a) pentene
    b) hexene
    c) heptene
    d) octene

13. The correct name for the alkene with the following structural formula:



is:

13. (continued)

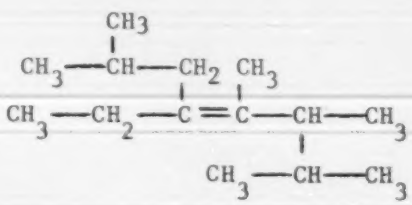
a) 2,2,3-trimethyl-4-n-propyl-5-isobutyl-1-hexene

b) 3 - n-propyl - 2 - tert. butyl - 4 - isobutyl hexene

c) 2,2,3,7 - tetramethyl- 4 - n-propyl - 5 - ethylene octane

d) 3 - n-propyl - 2 - isobutyl - 4 - tert. butyl 1 - hexene

14. The correct IUPAC name which ocrresponds to the alkene with the following structural formula:



is:

a) 3 - methyl - 2 - isopropyl - 4 - isobutyl - 3 - hexene

b) 2,3,4 - trimethyl - 5 - isobutyl - 4 - heptene

c) 2,3,4,7 - tetramethyl - 5 - ethyl - 4 - octene

d) 2,5,6,7 - tetramethyl - 4 - ethyl - 3 - octene

15. The correct IUPAC name which corresponds to this alkene:

$CH_3C(CH_3)\ CH\ CH\ [CH_2\ CH(CH_3)_2]\ CH\ (CH_3)_2$ is:

a) 2,5 - dimethyl - 4 - tert. butyl - 2 hexene

b) 2,6 - dimethyl - 4 - isopropyl - 2 - heptene

c) 2,6 - dimethyl - 4 - isobutyl - 2 - heptene

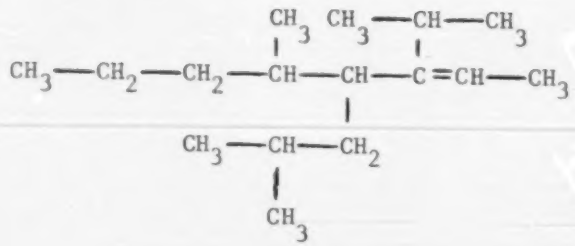
d) 2,6 - dimethyl - 4 - isopropyl - 5 - heptene

16. The structural formula which corresponds to:

5 - methyl - 3 - isopropyl - 4 - isobutyl - 2 - octene is:

SIP No. 7
Form B - Self Evaluation Exercise

a)



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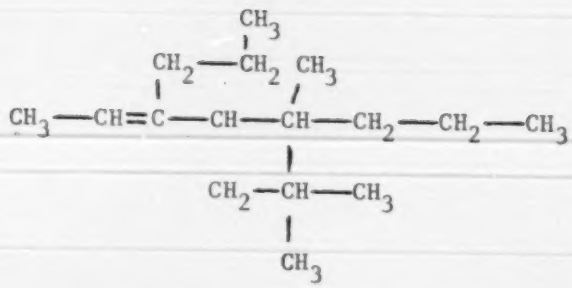

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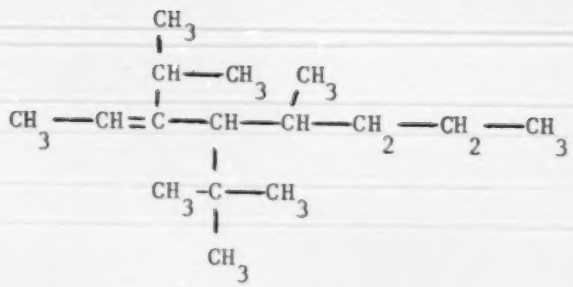

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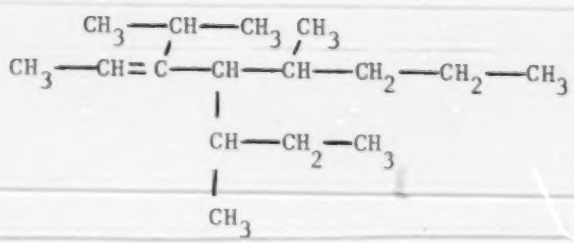


17. The structural formula which corresponds to the alkene:

2,3,6,6-tetramethyl-5-isopropyl-5-tert. butyl-2-heptene

is:

a) $CH_3\ C(CH_3)\ \ CH(CH_3)CH_2\ C[C(CH_3)_3]\ [CH(CH_3)_2]\ C(CH_3)_3$

b) $CH_3\ C(CH_3)\ C(CH_3)\ CH_2\ C[C(CH_3)_3]\ \ [CH_2CH_2CH_3]\ C(CH_3)_2\ CH_3$

c) $CH_3\ C(CH_3)\ C(CH_3)\ CH_2\ C[C(CH_3)_3]\ [CH(CH_3)_2]\ C(CH_3)_3$
c)

d) $CH_3C(CH_3)\ C(CH_3)\ CH_2C[CH_2CH(CH_3)_2]\ [CH(CH_3)_2]\ C(CH_2)_3CH_3$

18. From the INCORRECT IUPAC name for the alkene below, draw the correct structural formula and assign the CORRECT IUPAC name.

1-isobutyl-1-methyl-2-tert. butyl-2-isopropyl ethene

a) 2,4,6-trimethyl-3-tert. butyl-3-heptene

b) 2,2,4,6-tetramethyl-3-isopropyl-3-heptene

c) 2,4,6-trimethyl-5-tert. butyl-4-heptene

d) 2,2,4,5-tetramethyl-3-isopropyl-3-heptene

19. From the INCORRECT IUPAC name for the alkene below draw the correct structural formula and assign the CORRECT IUPAC name. Identify this as a,b,c,or d.

1-methyl-2-sec. butyl-3-isobutyl-1-propene

a) 2-methyl-5-isobutyl-5-heptene

b) 2-methyl-5-sec. butyl-5-heptene

c) 6-methyl-3-sec. butyl-2-heptene

d) 2,6-dimethyl-5-propylene octene

Self Instructional Package No. 7
Form C - Reference Guide

ALKENES

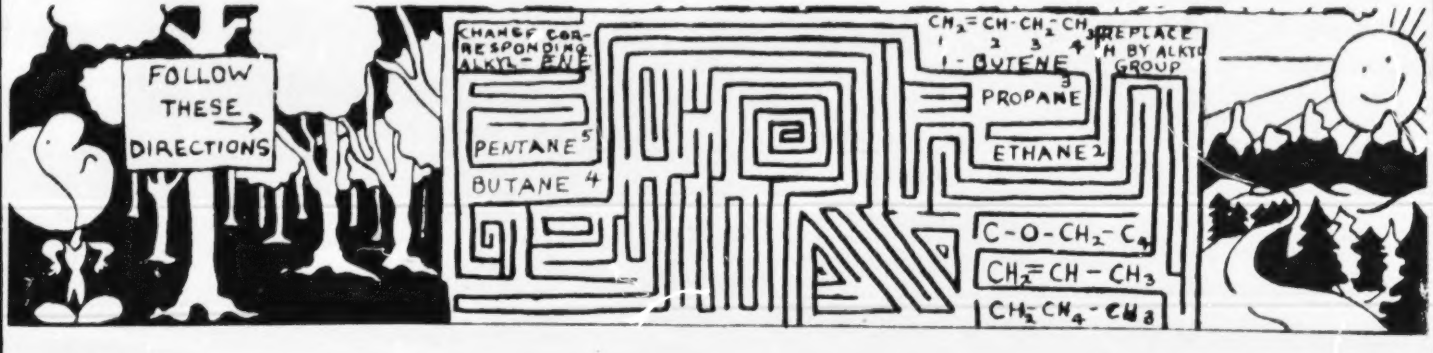
Sp^2 Hybridization, Geometric Isomerism, Nomenclature

The Reference Guide should be used in conjunction with Form B or the Self Evaluation Exercise. The references provide the correlation between the questions in Form B and the available material in the textbook and in the form of tapes.

Question 1	Chapter 5, Section 7
Questions 2,3,4,10	Chapter 5, Sections 2,3,4
Questions 5,6,7,8,9	Chapter 5, Sections 5,6
Questions 11,12,13,14,15,16,17,18,19	Chapter 5, Section 8

For Questions 1,2,3,4,5,6,7,8,9,10, additional explanation and examples can be found in Tape 2 - Alkenes - Sp^2 hybridization, Geometric Isomerism, with the accompanying work sheet and answer sheet.

For Questions 11,12,13,14,15,16,17,18,19, additional explanation and examples can be found in Tape 1 Alkenes - Nomenclature with the accompanying work sheet and answer sheet.



Self Instructional Package
Tape 1 - Worksheet

ALKENES

OBJECTIVE: To learn the IUPAC nomenclature of ALKENES.

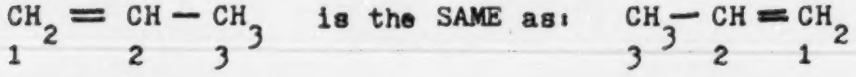
IUPAC RULES FOR THE NAMING OF ALKENES.

1. Select as the parent structure the longest continuous chain that CONTAINS THE CARBON- CARBON DOUBLE BOND; then consider the compound to have been derived from this structure by replacement of hydrogen by various alkyl groups. The parent structure is known as ETHENE, PROPENE, BUTENE, PENTENE and so on, depending upon the number of carbon atoms; each name is derived by changing the ending -ANE of the corresponding alkane name to -ENE.

2. Indicate by a number the position of the double bond in the parent chain. Although the double bond involves two carbon atoms, designate its position by the number of the FIRST doubly-bonded carbon encountered when numbering from the end of the chain nearest to the double bond.

3. Indicate by numbers the positions of the alkyl groups attached to the parent chain.

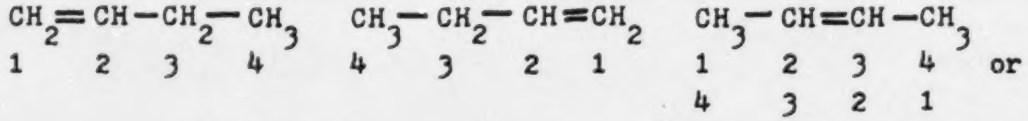
Example 1.



1-Propene 1-Propene

One propene existent

Example 2.

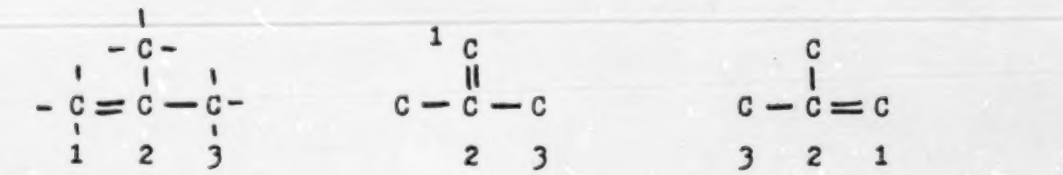


1-Butene ⟷ (the SAME as) 1-Butene 2-Butene

Two butenes existent (1-Butene and 2-Butene)

ASSIGNMENT 1. Draw the structural formulas of all the possible structural isomers of: a) Pentene b) Hexene c) Heptene d) Octene. Assign the correct IUPAC name to each one of them.

Example 3.



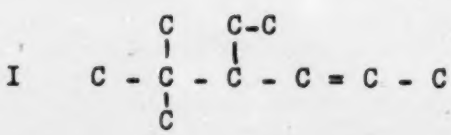
2-Methyl-1-Propene 2-Methyl-1-Propene 2-Methyl-1-Propene

OR 2-Methyl Propene 2-Methyl Propene 2-Methyl Propene

ALL OF THEM ARE THE SAME

Example 4. The possible structural isomers of 2-Methyl ? Pentene are:

ASSIGNMENT 2. Assign the correct IUPAC names to the compounds below:



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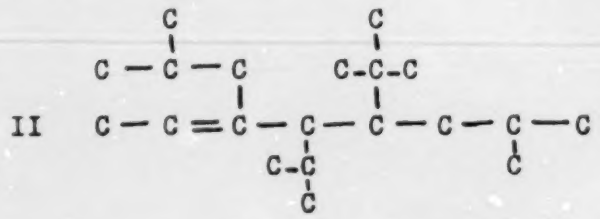
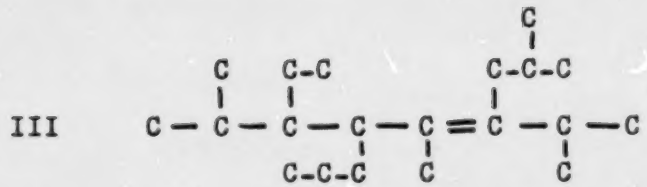
ASSIGNMENT 2. continued

II 

III 

ASSIGNMENT 3. Draw the structural formulas for the compounds listed below:

I 2,2,6- Trimethyl - 3 - ethyl - 4 - isopropyl-3 - Heptene

II 2,5,5,6- Tetramethyl - 3 - isopropyl - 4 - isobutyl - 2-Octene

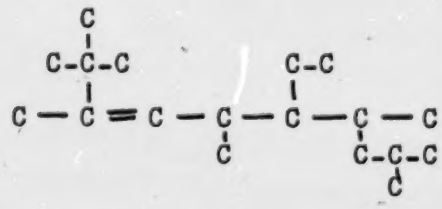
ASSIGNMENT 3. continued

III 6- Propyl - 4 - sec. butyl - 5 - n-butyl - 3 - Nonene

ASSIGNMENT 4.

Forgetful Frieda was asked to assign the correct IUPAC names to the alkenes below. As usual, she has forgotten something in every one of her answers. Find the missing element in each one of her answers and assign the correct IUPAC names.

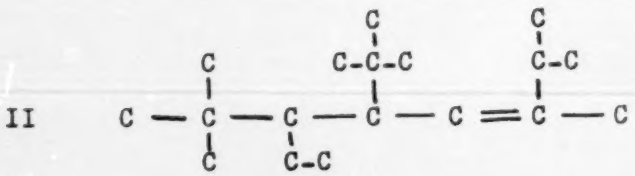
I



4- Methyl - 5 - ethyl - 2 - tert. butyl - 6 - isobutyl 2 - Heptene

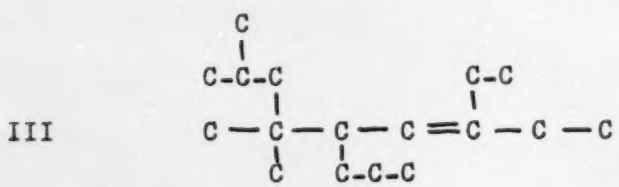
CORRECT IUPAC NAME: _____

ASSIGNMENT 4. continued

II 

2,2,6,7- Tetramethyl - 3 - ethyl - 4 - tert. butyl - 5 - Octene

CORRECT IUPAC NAME: _____

III 

6- Methyl - 3 - ethyl - 5 - n-propyl - 6 - isobutyl - 3 - Heptene

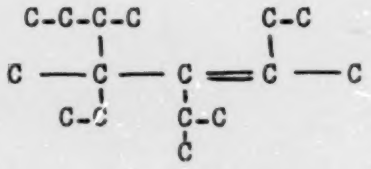
CORRECT IUPAC NAME: _____

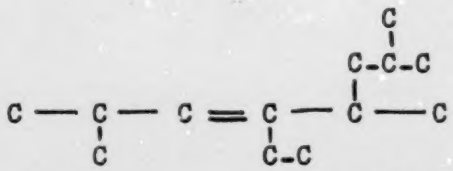
ASSIGNMENT 5.

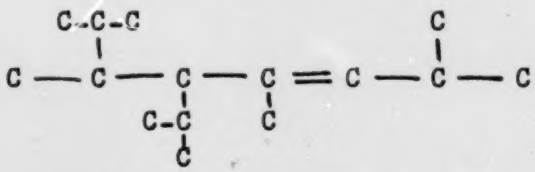
Confused Clyde has been given the task of assigning the correct IUPAC names to the structural formulas of the alkenes below. He has completed his task dilligently and for the most part correctly, but he listed the names in no particular order. You are asked to match the correct

ASSIGNMENT 5. continued

IUPAC name with the appropriate structural formula.

I 

II 

III 

a) 2,5,7- Trimethyl - 4 - ethyl - 3 - Octene

b) 3,5,6- Trimethyl - 5 - ethyl - 4 - isopropyl - 3 - Octene

c) 2,4,6,7- Tetramethyl - 5 - isopropyl - 3 - Octene

ASSIGNMENT 6. The names of the alkenes listed below are incorrect. From these incorrect names, draw the correct structural formulas and assign the CORRECT IUPAC names.

I 1-n-Propyl - 1 - ethyl - 2 - isobutyl - 2 - sec. butyl Ethene

ASSIGNMENT 6. continued

II 2- Isopropyl - 2 - tert. butyl - 3 - n-butyl Propene

III 2- sec. butyl - 3 - ethyl - 3 - n-propyl - 2 - Butene

Self Instructional Package
Tape 1 - Answer Sheet

ALKENES

ASSIGNMENT 1. Draw the structural formulas of all the possible structural isomers of : a) Pentene b) Hexene c) Heptene d) Octene. Assign the correct IUPAC name to each one of them.

a) $CH_2=CH-CH_2-CH_2-CH_3$ 1-Pentene

$CH_3-CH=CH-CH_2-CH_3$ 2-Pentene

($CH_3-CH_2-CH=CH-CH_3$ 2-Pentene - SAME AS THE ONE ABOVE)

b) $CH_2=CH-CH_2-CH_2-CH_2-CH_3$ 1-Hexene

$CH_3-CH=CH-CH_2-CH_2-CH_3$ 2-Hexene

$CH_3-CH_2-CH=CH-CH_2-CH_3$ 3-Hexene

c) - C = C - C - C - C - C - C - 1-Heptene

- C - C = C - C - C - C - C - 2-Heptene

- C - C - C = C - C - C - C - 3-Heptene

1 2 3 4 5 6 7

(- C - C - C - C = C - C - C - 3-Heptene - SAME AS THE ONE ABOVE)

7 6 5 4 3 2 1

ASSIGNMENT 1. continued

d) - C ≡ C - C - C - C - C - C - C - 1-Octene

- C - C ≡ C - C - C - C - C - C - 2-Octene

- C - C - C ≡ C - C - C - C - C - 3-Octene

- C - C - C - C ≡ C - C - C - C - 4-Octene

Example 4. Answer 2 - Methyl ? Pentene

a) $C \equiv {}^{2}C - {}^{3}C - {}^{4}C - {}^{5}C$ (C on 2) 2-Methyl-1-Pentene

b) $C - {}^{2}C \equiv {}^{3}C - {}^{4}C - {}^{5}C$ (C on 2) 2-Methyl-2-Pentene

c) $C - {}^{5}C - {}^{4}C \equiv {}^{3}C - {}^{2}C$ (C on 3) 4-Methyl-2-Pentene

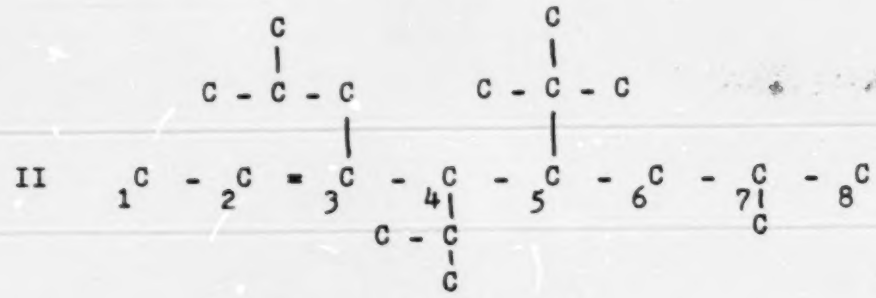
(Remember RULE 2. for the IUPAC naming of ALKENES)

d) $C - {}^{5}C - {}^{4}C - {}^{3}C \equiv {}^{2}C$ (C on 4) 4-Methyl-1-Pentene

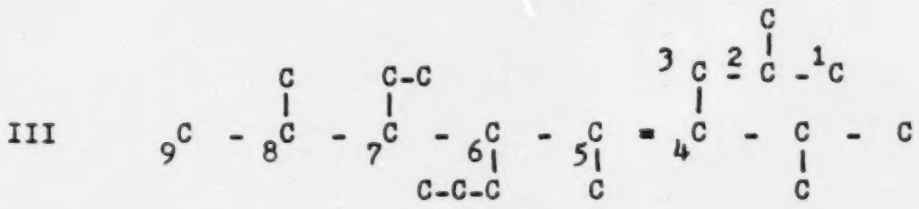
ASSIGNMENT 2. Assign the correct IUPAC names to the compounds below:

I $C - {}^{5}C(C)(C) - {}^{4}C(C) - {}^{3}C = {}^{2}C - {}^{1}C$ 5,5-Dimethyl-4-ethyl-2-Hexene

ASSIGNMENT 2. continued

II 

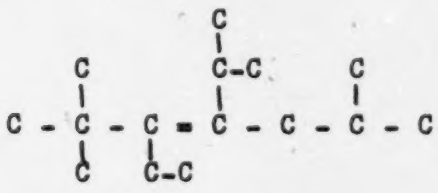
7-Methyl-4-isopropyl-3-isobutyl-5-tert. butyl-2-Octene

III 

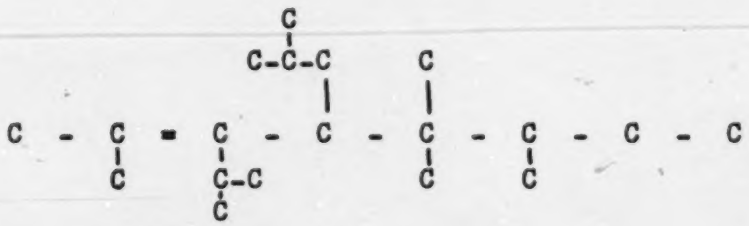
2,5,8-Trimethyl-7-ethyl-4-isopropyl-6-n-propyl-4-Nonene

ASSIGNMENT 3. Draw the structural formulas for the compounds listed below:

I 2,2,6-Trimethyl-3-ethyl-4-isopropyl-3-Heptene

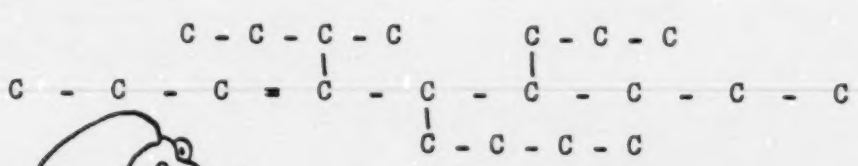


II 2,5,5,6-Tetramethyl-3-isopropyl-4-isobutyl-2-Octene



ASSIGNMENT 3. continued

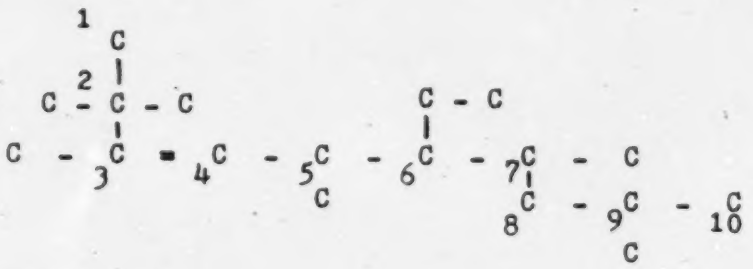
III 6-Propyl-4-sec. butyl-5-n-butyl-3-Nonene



ASSIGNMENT 4.

Forgetful Frieda was asked to assign the correct IUPAC names to the alkenes below. As usual, she has forgotten something in every one of her answers. Find the missing element in each one of her answers and assign the correct IUPAC names.

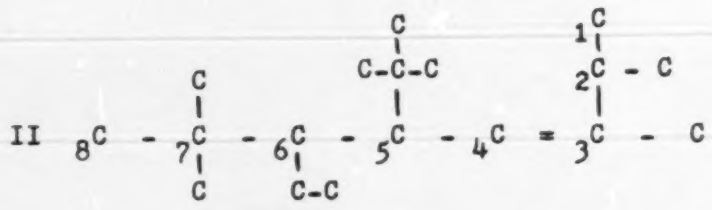
I



CORRECT IUPAC NAME:

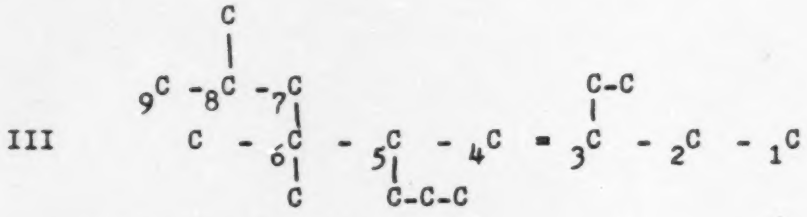
2,2,3,5,7,9-Hexamethyl-6-ethyl-3-Decane

ASSIGNMENT 4. continued

II 

CORRECT IUPAC NAME:

2,3,7,7-Tetramethyl-6-ethyl-5-tert, butyl-3-Octene

III 

CORRECT IUPAC NAME:

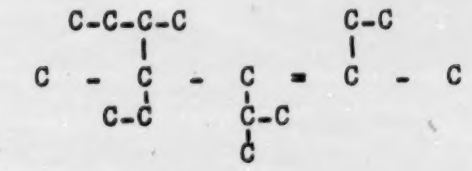
6,8-Dimethyl-3-ethyl-5-n-propyl-3-Nonene

ASSIGNMENT 5.

Confused Clyde has been given the task of assigning the correct IUPAC names to the structural formulas of the alkenes below. He has completed his task dilligently and correctly for the most part, but he listed the names in no particular order. You are asked to match the correct IUPAC name with the appropriate structural formula.

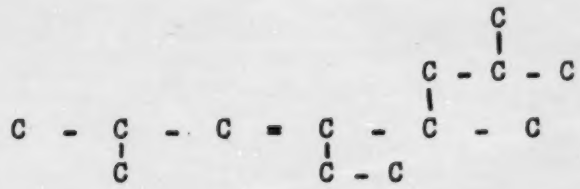
ASSIGNMENT 5. continued

I



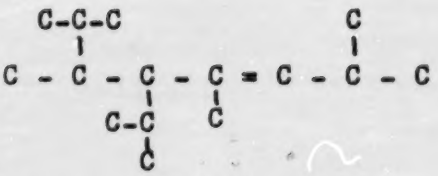
NAME: b

II



NAME: a

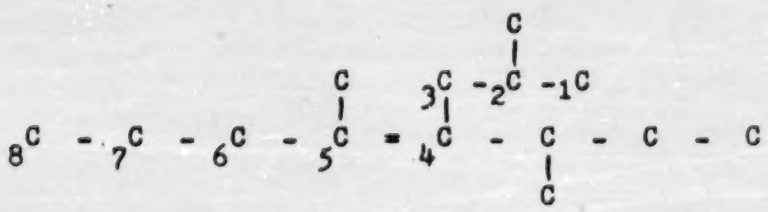
III



NAME: c

ASSIGNMENT 6. The names of the alkenes listed below are incorrect. From these incorrect names, draw the correct structural formulas and assign the CORRECT IUPAC names.

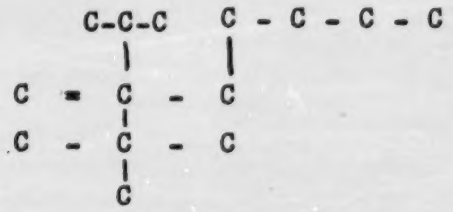
I 1-n-Propyl-1-ethyl-2-isobutyl-2-sec. butyl Ethene (INCORRECT)



CORRECT IUPAC NAME: 2,5-Dimethyl-4-sec. butyl-4-Octene

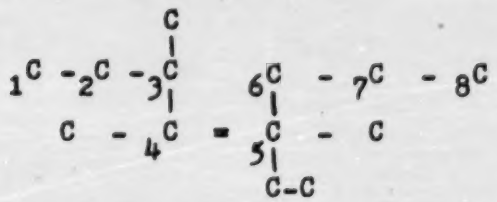
ASSIGNMENT 6. continued

II 2-Isopropyl-2-tert. butyl-3-n-butyl Propene
(INCORRECT)



CORRECT IUPAC NAME: 2-Isopropyl-2-tert. butyl-1-Heptene

III 2-sec. butyl-3-ethyl-3-n-propyl-2-Butene
(INCORRECT)



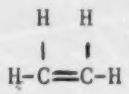
CORRECT IUPAC NAME: 3,4,5-Trimethyl-5-ethyl-4-Octene

Self Instructional Package No. 7
Tape 2 - Work Sheet

ALKENES

Sp^2 Hybridization, Geometric Isomerism

Example No. 1 - ethylene

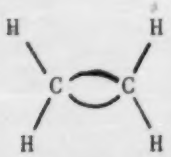


structural formula

C_2H_4

molecular formula

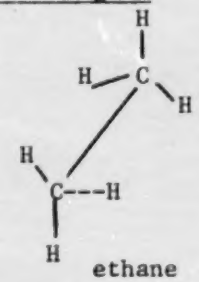
Example No. 2 - shape of ethylene and its bond angles



ethylene

Shape: trigonal (flat, planar)

$\alpha = 120°$



ethane

Shape: tetrahedral (three-dimensional)

$\alpha = 109°$

Example No. 3 - Sp^2 hybridization

Ground state electron configuration on carbon.

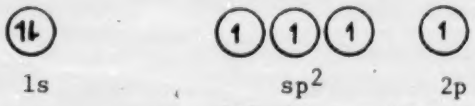
1s 2s 2p

Step 1 - promotion of an electron from 2S atomic orbital to 2 p atomic orbital. Result: four unpaired electrons.

1s 2s 2p

SIP No. 7
Tape 2 - Work Sheet

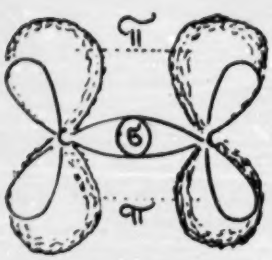
Step 2 - "mixing" of <u>one</u> S atomic orbital and <u>two</u> p atomic orbital.
Result: three equivalent Sp^2 hybrid atomic orbitals.



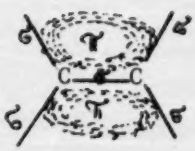
α = 120°

three Sp^2 hybrid atomic orbitals of carbon

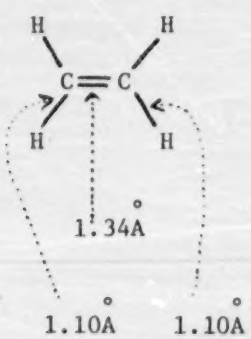
<u>Example No. 4</u> - <u>bond formation</u>

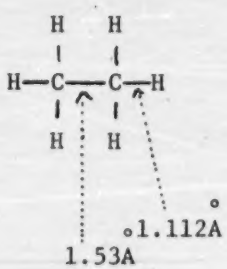


same as:



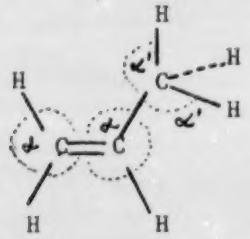
<u>Example No. 5</u> - <u>bond lengths</u>





SIP No. 7
Tape 2 - Work Sheet

Example No. 6 - propylene or propene



$\alpha = 120°$

$\alpha' = 109.5°$

C_3H_6

molecular formula

Assignment No. 1

Consider the molecule of 1-butene $CH_2{=}CH{-}CH_2{-}CH_3$ and answer the following questions:

1. What are the bond angles around Carbon No. 1?
2. What are the bond angles around Carbon No. 2?
3. What are the bond angles on Carbon No. 3?
4. What are the bond angles on Carbon No. 4?

Compare the following bond lengths qualitatively:

5. C_1-C_2 and C_2-C_3
6. C_2-C_3 and C_3-C_4
7. C_1-H and C_4-H

Asignment No. 2

a) From the molecular formulas of ethylene (Example No. 1), propene (Example No. 6) and butene (Example No. 7) arrive at the general molecular formula for all alkenes: C_nH ?

b) Write the molecular formulas for the following alkenes:

(1) heptene

(2) nonene

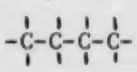
(3) pentene

(4) octene

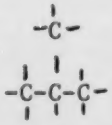
SIP No. 7
Tape 2 - Work Sheet

Example No. 7 - structural isomers of butane and butene

BUTANES



n-butane

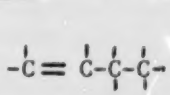


isobutane

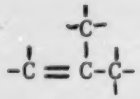
C_4H_{10}

molecular formula

BUTENES



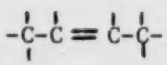
1-butene



isobutene

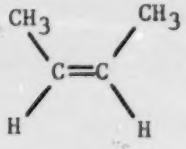
C_4H_8

molecular formula

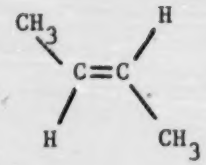


2-butene

Example No. 8 - isomers of 2-butene



I



II

1. Do configurations I and II have the same molecular formula? _____
2. Do configurations I and II have the same structure? _____
3. Do configurations I and II have the same arrangement of atoms or space? _____.
4. Are configurations I and II superimposable?
5. Are configurations I and II mirror image isomers? _____
6. Can configurations I and II be converted into each other? _____

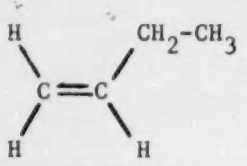
SIP No. 7
Tape 2 - Work Sheet

Is I cis or trans isomer? _____

Is II cis or trans isomer? _____

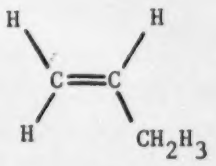
Geometric isomers (cis and trans isomers) are diastereoisomers which owe their existence to the hindered rotation about the carbon-carbon double bond.

Example No. 9 - Geometric isomers of 1-butene



cis ?

I



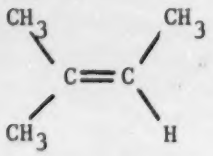
trans ?

II

Are I and II superimposable? _____

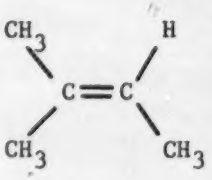
Are I and II geometric isomers? _____

Example No. 10 - Geometric isomers of 2-methyl-2-butene



cis ?

I



trans ?

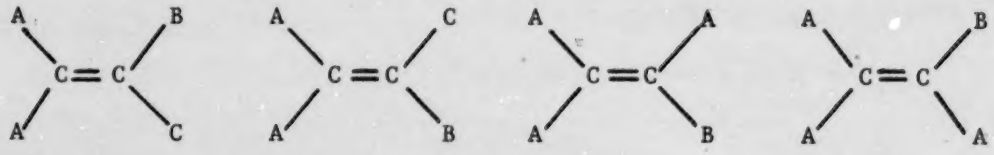
II

Are I and II superimposable? _____

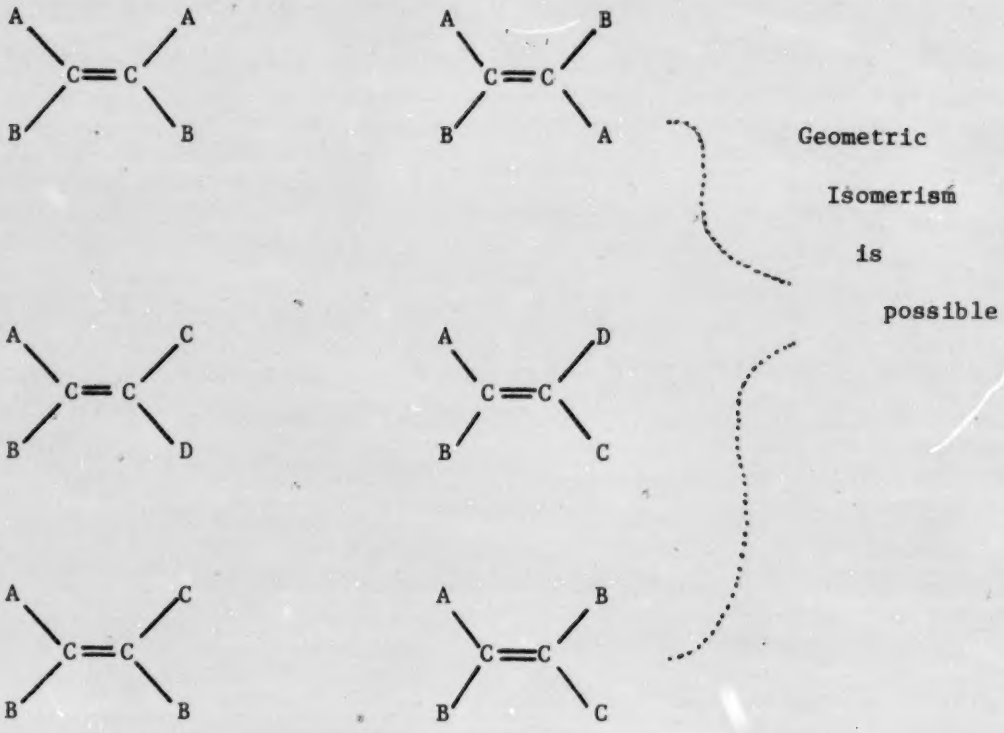
Are I and II geometric isomers? _____

SIP No. 7
Tape 2 - Work Sheet

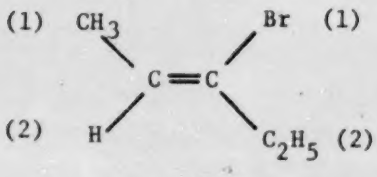
Example No. 11



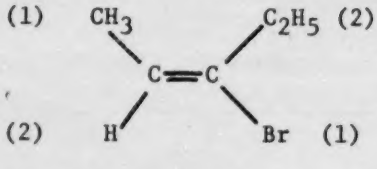
No geometric isomerism



Example No. 12 - Geometric isomers of 3-bromo-2-pentene



I
Z configuration



II
E configuration

SIP No. 7
Tape 2 - Work Sheet

Example No. 12 (continued)

Is I cis or trans configuration? _____

Is II cis or trans configuration? _____

Assignment No. 3

1. Draw the structures of all the structural and geometric isomers of:

   A) pentenes C_5H_{10}

   b) monochloropropene C_3H_5Cl

   c) monobromobutene C_4H_7Br

SIP No. 7
Tape 2 - Work Sheet

Assignment No. 4

From the compounds given below identify the ones which can exist as geometric isomers and draw their corresponding Z and E (cis and trans) configurations. (Specify each as Z and E)

a) 1,1-dichloro-1-butene

b) 3-methyl-2-hexene

c) 3-ethyl-2-pentene

d) 1-bromo-2-methyl-1-butene

e) 2-chloro-3-bromo-2-pentene

Assignment No. 5

Draw the structures of the following compounds:

a) Z-2-bromo-2-butene

b) trans-3-hexene

c) E-3-bromo-3-hexene

d) Z-3-bromo-4-methyl-3-hexene

Self Instructional Package No. 7
Tape 2 - Answer Sheet

ALKENES

Sp^2 hybridization, geometric isomerism

Assignment No. 1

1. 120°
2. 120°
3. 109.5°
4. 109.5°
5. C_1-C_2 bond is shorter than C_2-C_3 bond
6. C_2-C_3 bond is shorter than C_3-C_4 bond
7. C_1-H bond is shorter than C_4-H bond

(greater the S character of an atomic orbital on a given atom, shorter the bond)

Assignment No. 2

a) $C_n H_{2n}$

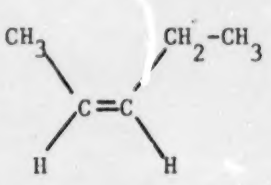
b) 1. C_7H_{14} 3. C_5H_{10}

2. C_9H_{18} 4. C_8H_{16}

Assignment No. 3

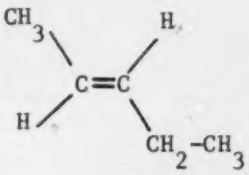
a) 1. $CH_2=CH-CH_2-CH_2-CH_3$

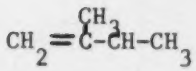
2.

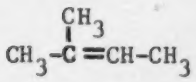


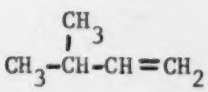
SIP No. 7
Tape 2 - Answer Sheet

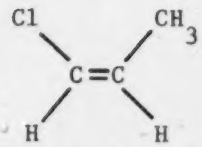
Assignment No. 3 (continued)

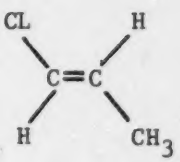
a) 3. 

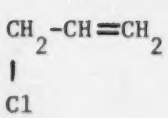
4. 

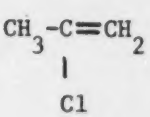
5. 

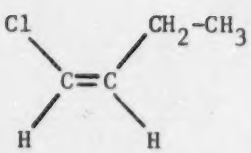
6. 

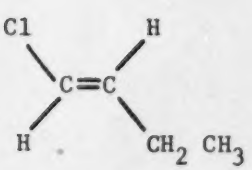
b) 1. 

2. 

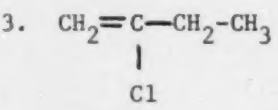
3. 

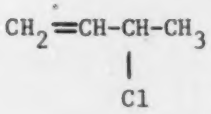
4. 

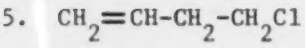
c) 1. 

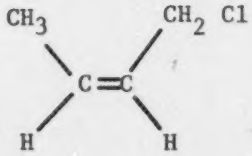
2. 

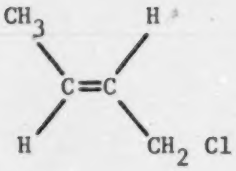
c) (continued)

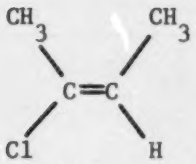
3. 

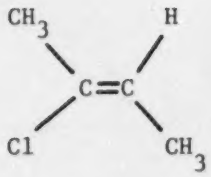
4. 

5. 

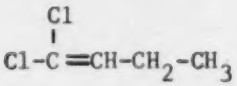
6. 

7. 

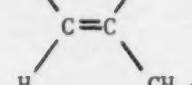
8. 

9. 

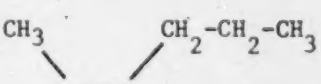
Assignment No. 4

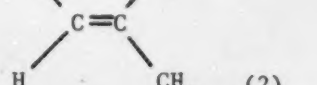
a)  no geometric isomerism

b) (1) (2)

(2)  (1)

E - configuration

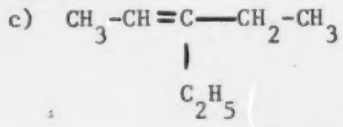
(1)  (1)

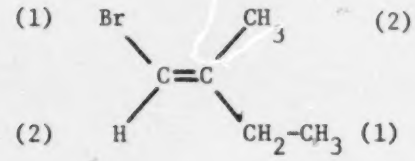
(2)  (2)

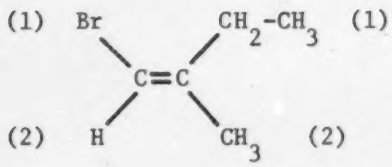
Z - configuration

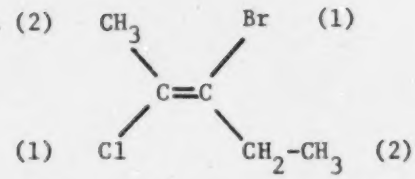
SIP No. 7
Tape 2 - Answer Sheet

Assignment No. 4 (continued)

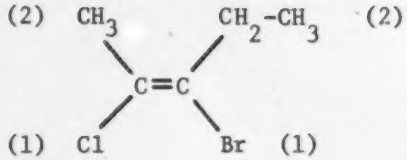
c)  no geometric isomerism

d) 



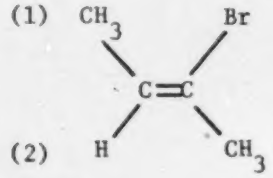
e) 

Z - configuration

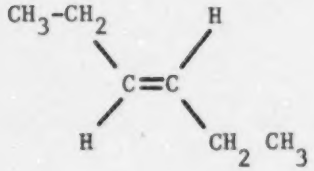


E - configuration

Assignment No. 5

a) 

Z - 2-bromo-2-butene

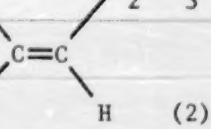
b) 

trans-3-hexene

40

Assignment No. 5 (continued)

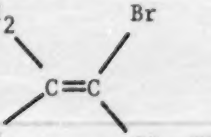
c) (2) $CH_3\ CH_2$ $CH_2\ CH_3$ (1)



(1) Br H (2)

E - 3-bromo-3-hexene

d) (1) $CH_3\ CH_2$ Br (1)



(2) CH_3 $CH_2\ CH_3$ (2)

Z - 3-bromo-4-methyl-3-hexene

Self Instructional Package No. 7
Form D - Progress Check Evaluation

ALKENES

Sp^2 hybridization, Geometric Isomerism, Nomenclature

Identify the statements below as True or False by placing a capital T or F in the space to the left.

1. _____ In the Sp^2 hybridization an S atomic orbital "mixes" with three p atomic orbitals to yield three equivalent Sp^2 hybrid atomic orbitals.

2. _____ The π electron cloud contains two electrons.

3. _____ The π bond is formed when the p A.O. from carbon 1 overlaps with the p A.O. from carbon 2.

4. _____ The carbon-carbon σ bond in ethylene results from the overlap of an Sp^3 hybrid atomic orbital on carbon 1 and an Sp^3 hybrid atomic orbital on carbon 2.

5. _____ Ethylene owes its flat, planar shape to the Sp^2 hybridization on the carbon atom.

6. _____ The Sp^2 hybrid atomic orbitals point to the corners of a regular tetrahedron.

7. _____ A σ bond resulting from an overlap of Sp^2 A.O. on one carbon and Sp^3 A.O. on the other carbon is longer than the σ bond resulting from the overlap of Sp^3 A.O. on one carbon and Sp^3 A.O. on the other carbon.

8. _____ A carbon-carbon double bond is stronger and consequently longer than a carbon-carbon single bond.

9. _____ The bond dissociation energy of the carbon-carbon double bond is higher than the bond dissociation energy of the carbon-carbon single bond.

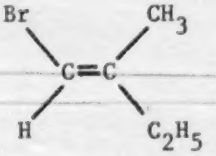
10. _____ The bond angles formed by the double bonded carbon atom are 120°.

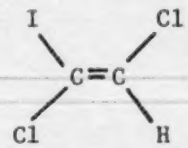
Circle the correct answer or answers in the following questions:

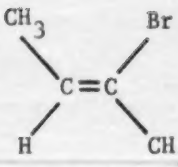
11. The compounds which can exist as Z and E (or cis and trans) isomers are:

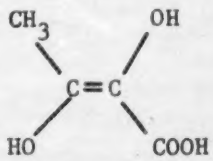
    a) 2,3-dibromo-2-butene
    b) 2-methyl-2-hexene
    c) 1-bromo-2-methyl-1-pentene
    d) 3-octene

12. Identify the Z configurations among the ones given below:

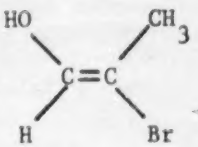
a) 

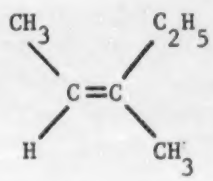
c) 

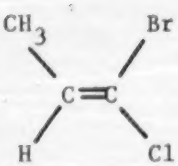
b) 

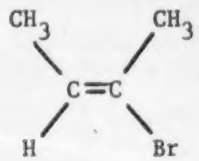
d) 

13. Identify the E configurations among the ones given below:

a) 

c) 

b) 

d) 

14. The correct statements about the geometric isomers are:

a) they owe their existence to the hindered rotation about the carbon-carbon double bond.

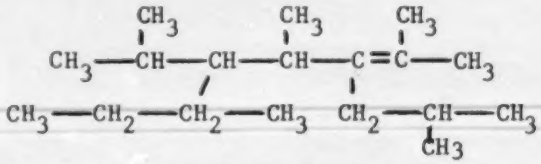
b) they have identical physical properties.

c) they are not superimposable.

d) they can exist in two different forms: Z and E.

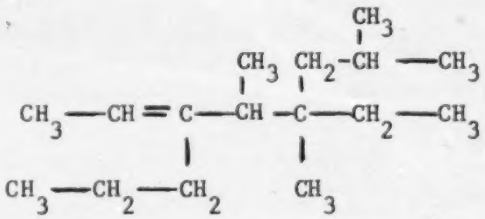
15. The longest carbon atom chain in the alkene below consists of how many carbon atoms?

a) 7
b) 8
c) 9
d) 10

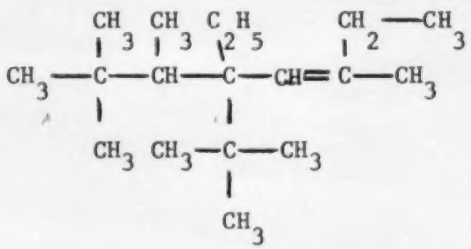


16. The alkene with the following structure can be considered a derivative of:

a) heptene
b) octene
c) nonene
d) decene



17. The correct IUPAC name for the alkene with the structural formula:



is:

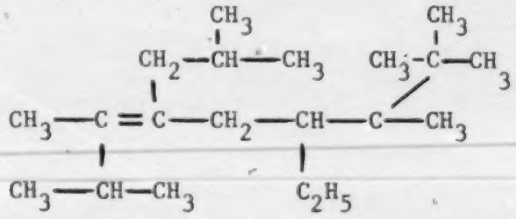
a) 2,2,3-trimethyl-4,6-diethyl-4-tert. butyl-5-heptene

b) 2,2,3,6-tetramethyl-4-ethyl-4-tert. butyl-5-octene

c) 3,6,7,7-tetramethyl-5-ethyl-5-tert. butyl-2-octene

d) 3,6,7,7-tetraethyl-5-ethyl-5-tert. butyl-3-octene

18. Identify the correct IUPAC name for the alkene with the structural formula:



a) 2,3,7,8,8-pentamethyl-6-ethyl-4-isobutyl-3-nonene

b) 6,7,7-trimethyl-5-ethyl-2-isopropyl-3-isobutyl-2-octene

c) 2,2,3,7,8-pentamethyl-4-ethyl-6-isobutyl-6-nonene

d) 2,3,7,8,8-pentamethyl-6-ethyl-4-sec. butyl-3-nonene

19. The correct IUPAC name for the alkene:

$CH_3CH_2\ C[CH(CH_3)_2]\ C(CH_3)\ C(CH_2CH_3)\ [CH(CH_3)_2]\ CH_2CH(CH_3)CH_3$ is:

a) 4-methyl-5-ethyl-3-isopropyl-5-isobutyl-3-heptene

b) 2,4,7-trimethyl-3,5-diethyl-5-isopropyl-3-octene

c) 4,7-dimethyl-5-ethyl-3,5-diisopropyl-3-octene

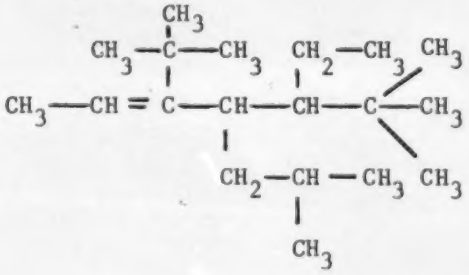
d) 2,5-dimethyl-4-ethyl-4,6-diisopropyl-5-octene

20. The structural formula which corresponds to:

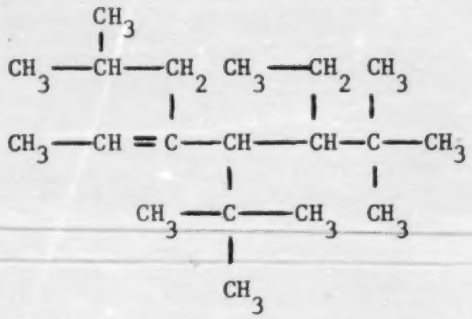
6,6-dimethyl-5-ethyl-3-isobutyl-4-tert. butyl-2-heptene

is:

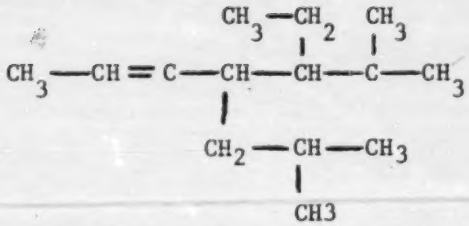
a)



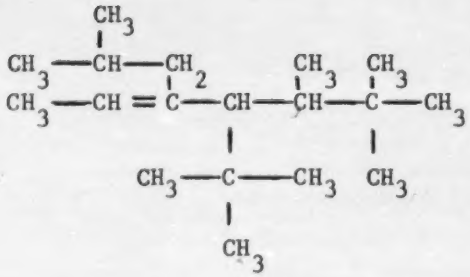
20. b)



c)



d)



21. The correct formula which corresponds to:

2,2,7-trimethyl-4-ethyl-5-isobutyl-4-octene is:

a) $CH_3C(CH_3)_2\ CH_2C(CH_2CH_3)\ C[CH_2CH(CH_3)CH_3]\ CH_2CH(CH_3)_2$

b) $CH_3C(CH_3)_2\ CH_2C(CH_2CH_3)\ C[C(CH_3)_3]\ CH_2CH(CH_3)CH_3$

c) $CH_3C(CH_3)_2\ CH\ C(CH_2CH_3)\ CH[CH_2CH(CH_3)CH_3]\ CH_2CH(CH_3)CH_3$

d) $CH_3\ C(CH_3)_2\ CH\ C(CH_2CH_3)\ CH[CH_2(CH_3)CH_2CH_3]\ CH_2\ CH(CH_3)_2$

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22. You are given an INCORRECT name for an alkene. It is:

1-isobutyl-1-isopropyl-2-tert. butyl ethene

Draw the correct structural formula and identify its IUPAC name as a,b,c, or d.

a) 2,2,5-trimethyl-4-isobutyl-3-hexene

b) 2,2,6-trimethyl-4-isopropyl-3-heptene

c) 2,2,5-trimethyl-4-isopropyl-3-octene

d) 2,2,5,5,-tetramethyl-4-isopropyl-3-heptene

23. From the INCORRECT name of an alkene which is:

3-methyl-2-ethyl-2-isopropyl-4-sec. butyl-3-hexene

a) 2,3,4,6-tetramethyl-3-ethyl-4-octene

b) 3,5,6,7-tetramethyl-6-ethyl-4-octene

c) 3,4,6-trimethyl-3-isopropyl-4-octene

d) 2,4,6-trimethyl-3-ethyl-4-octene

Self Instructional Package No. 7
Form B^1 - Self Evaluation Exercise - Answers

ALKENES

Sp^2 Hybridization, Geometric Isomerism, Nomenclature

1.	b	11.	b
2.	a, c	12.	b
3.	b, c, d	13.	a
4.	c, d	14.	c
5.	a, c, d	15.	b
6.	b, c	16.	a
7.	b, d	17.	c
8.	a, d	18.	a, b
9.	a, b	19.	c
10.	a, b, d		

Self Instructional Package No. 7
Form D^1 - Progress Check Evaluation - Answers

ALKENES

Sp^2 Hybridization, Geometric Isomerism, Nomenclature

1.	F	11.	a, c, d	21.	a
2.	T	12.	b, c	22.	b
3.	T	13.	a, d	23.	a, c
4.	F	14.	a, c, d		
5.	T	15.	b		
6.	F	16.	b		
7.	F	17.	d		
8.	F	18.	a		
9.	T	19.	b, c		
10.	T	20.	b		